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The Berlin Script Collective

Comparing scripts and scripting comparisons. Toward a systematic analysis of technologically mediated influence

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Comparing scripts and scripting comparisons. Toward a systematic analysis of technologically mediated influence

The Berlin Script Collective[1]

Abstract:
While it is generally accepted in Science and Technology Studies that technological artefacts have an impact on human practices, the question how this impact is achieved has been answered idiosyncratically for each case studied. This gap between abstract theoretical conceptualisations of non-human agency and largely descriptive accounts of many empirical instances to which they are applied is difficult to overcome unless the agency of artefacts can be compared. The aim of this paper is to propose and test a theoretically grounded framework that enables comparisons of agential qualities of technologies. In order to compare the ways in which technologies influence human behaviour, technology needs to be positioned in social theory. We do so by arguing that technology is one of three distinct modes of exercising influence, positioning technology in a general framework of kinds and modes of influence, and utilising Akrich's notion of scripts to capture the mediation of influence as a particular property of technology. From this, we derive a framework for comparing scripts in seven dimensions. We apply this framework to a test of conflicting hypotheses about consequences of the increasing sophistication of technology and to the exploration of the complexity underlying a typology of 'persuasive technologies'. Our 'proof of concept' enables the conclusion that comparative studies of technologies enable unique contributions to Science and Technology Studies as well as related fields like studies on techno-regulation.

Keywords:
Sociology of technology – framework for comparison – technological scripts – social theory – agency of artefacts

[1] This article is the outcome of a reading group on the comparison of technologies ("Berlin Script Collective"). Members are (in alphabetical order) Jochen Gläser, Daniel Guagnin, Grit Laudel, Martin Meister, Fabia Schäufele, Cornelius Schubert, and Ulla Tschida.

Zusammenfassung:
Die Science and Technology Studies sind sich zwar darin einig, dass Technik menschliche Praktiken beeinflusst, geben jedoch bislang auf die Frage, wie das geschieht, für jeden untersuchten Fall eine idiosynkratische Antwort. Diese Lücke zwischen abstrakten Konzeptualisierungen nicht-menschlicher Agency und Einzelfallbeschreibungen kann nicht überwunden werden, solange die Agency von Artefakten nicht verglichen werden kann. Das Ziel dieses Papers ist es, einen theoretisch begründeten Vergleichsrahmen für handlungsbeeinflussende Eigenschaften von Technik vorzuschlagen und zu testen. Um Formen der Beeinflussung menschlichen Verhaltens durch Technik vergleichen zu können, muss letztere in die Sozialtheorie eingeordnet werden. Wir tun das, indem wir Technik in einen allgemeinen Rahmen von Arten und Modi der Beeinflussung einordnen und Akrichs Konzept des Skripts für die Erfassung der handlungsbeeinflussenden Eigenschaften von Technik nutzen. Daraus entwickeln wir einen Vergleichsrahmen für Skripte mit sieben Dimensionen. Diesen Vergleichsrahmen wenden wir in einem Test einander widersprechender Hypothesen über Folgen einer steigenden Komplexität der Technik sowie in der Erkundung der Komplexität einer Typologie von ‚Beeinflussungstechnologien' an. Unsere ‚Pilotstudie' gestattet die Schlussfolgerung, dass vergleichende Studien von Technologien neuartige Beiträge zu den Science and Technology Studies sowie zu angrenzenden Gebieten wie den Studien zur Techno-Regulation ermöglichen.

Schlüsselwörter:
Techniksoziologie – Vergleichsrahmen – technische Skripte – Sozialtheorie – Agency von Artefakten

Contents

1. Introduction

In this paper, we address a major obstacle to progress in the understanding of the agency of technology, namely the lack of frameworks for the *comparative* study of technologies and the ways in which they shape human practice. The analysis of the agency of technology is one of the major concerns of Science and Technology Studies (STS). However, while the question *if* technological artefacts have an impact on human practices is not under debate anymore, the question *how* this impact is achieved has been answered idiosyncratically for each case studied. This accumulation of many different answers to that question seems to make a synthesis impossible. The gap between abstract theoretical conceptualisations of non-human agency, e.g. in terms of Actor-Network-Theory (ANT), and largely descriptive accounts of many empirical instances to which they are applied appears to be disappointingly stable.

The recent turn to a 'new materialism' mostly rephrases the initial 'if' question of STS, but does not solve the problem of making the diverse 'hows' more comparable. The discussion of material agency keeps oscillating between abstract concepts developed in the 1980s and 1990s and individual descriptions of particular cases (Knappett and Malafouris 2008; Pickering and Guzik 2008; Coole and Frost 2010), and we are hard pressed to find a systematic link between empirical case studies and abstract problems.

We ascribe this gap to the inability to compare the agency of artefacts, i.e. to find commonalities of and differences between the ways in which artefacts shape actions. As Latour has emphasised, there is a difference between a stop-sign and a speed-bump, the second usually being more effective in influencing human behaviour (Latour 1992: 243-244). But which differences do *produce* this varying effectiveness? And how can these differences be properly considered in a framework that can be extended to other traffic-regulating technologies, let alone technologies with different purposes? These questions cannot be answered by simple references to weight and solidity of things. Comparing the ways in which technologies influence behaviour requires approaches that include materiality and acknowledge the complexity of both technology and human behaviour.

We see four reasons why STS should find ways to compare technologies. First, the absence of a comparative framework for technologies circumvents to relate the findings of the abundant case studies on technical agency to each other. This not only corrupts any possibility of operating on and contributing to a shared state of the art, but also decouples the case studies from more general accounts of technological agency and thus significantly impedes an empirically driven or at least empirically informed development of concepts and theories.

Second, a framework could inform case studies, which currently use ad-hoc descriptions that are 'short-circuited' with highly abstract concepts. This is what makes case studies idiosyncratic

and prevents them from serving to extend and inform theoretical discussions. Because the abstract concepts are not sensitive enough to detect differences in material agency, the specifics of technical agency in different situations are lost to them.

Third, a comparative framework would support and connect more specific diagnoses of technology's increasing role in creating and maintaining social order. The recent literature on "regulation by design" (Yeung 2008) or techno-regulation (Brownsword 2005) recognises that influence can be exercised through architecture and technological design. Scholars discuss how software code can be regarded as law (Lessig 1999), whether "techno-regulation" can be considered as regulation (Leenes 2011), and how this comparison applies to issues of legitimacy and democracy (Koops 2008; Hildebrandt 2011). Similar arguments are being developed in a discussion that is best termed 'critical algorithm studies', which discusses the possibility to shape human behaviour through algorithms (Barocas et al. 2013; Ziewitz 2016a; Kitchin 2017). Partly building on STS, these new discussions appear to be split between highly abstract arguments and an ad-hoc use of 'sample technologies' in very much the same way. Moving forward requires understanding the options accessible to regulators and designers, which in turn means that the regulative powers of technologies need to be compared to each other as well as to traditional forms of regulation by law.

A fourth reason is a possible further contribution by STS to social theory. The social sciences have extensively studied the functioning and the effectiveness of instructions, rules, roles or norms in different types of social situations but have largely shied away so far from considering the ordering by technology as distinct and equifinal. Rendering technologies comparable through concepts at middle levels of abstraction may make it possible for the social sciences to tap into the wealth of STS knowledge on that topic.

The aim of this paper is to propose and test a theoretically grounded framework that enables comparisons of agential qualities of technologies. This aim is rather specific in that it does not address many concerns of technology studies including the use of technological potential rather than the technology itself for influencing others (e.g. nuclear weapons), the role of technology in enhancing human action capabilities, the unpredictability or the variability of creative situational uses of technology. However, the comparison of agential qualities addresses one traditional line of research we believe to require methodological progress.

The theoretical basis of our framework is the conceptualisation of technology as a medium through which human actors can be influenced, and of technologically mediated influence as a distinct mode of influence besides interactive and socio-structurally mediated influence. The concept 'script' that was proposed by (Akrich 1992) reflects the influence of technology designers

on technology users, and may thus serve as a basis for a comparative framework for technologies (2). We apply this framework to an exploration of the complexity underlying Fogg's (2003) typology of "persuasive technologies" and to the test of conflicting hypotheses about consequences of the increasing sophistication of technology (3). Our discussion addresses the role of materiality in our framework (4). Conclusions concern possible contributions of comparative studies of technologies (5).

2. Technology as a medium for influence

The idea that technology is a medium through which human behaviour is influenced is a fundamental theoretical insight.[2] However, the proponents of ANT have never embedded this insight in any general social theory of the shaping of human behaviour. As a consequence, the idea is difficult to use in connection with other approaches to the shaping of human behaviour. In order to compare the ways in which technologies influence human behaviour, technology needs to be positioned in social theory. We do so by arguing that technology is one of three distinct means of exercising influence and positioning technology in a general framework of kinds and modes of influence. We then utilise Akrich's notion of scripts to capture the mediation of influence as a particular property of technology and derive a comparative framework for scripts.

2.1 The exercise of influence

In order to theoretically ground our comparative framework, we use a generalised concept of influence. This requires a clarification of the relationship between the concepts 'influence' and 'power'. The second concept is more commonly used in sociology but has also been criticised for its ambiguity. Power is considered in sociology as a relationship between actors, which leads to the two interdependent perspectives on power as the ability to alter others' behaviour and the ability to disobey. The first perspective can be traced back to Weber, who understood power as "any chance to enforce one's will in a social relationship, if necessary against resistance and regardless of the basis on which this chance rests" (Weber 1976 [1922]: 28, our translation). To have power, then, is to be obeyed. This idea underlies the common definition of power "A has power over B to the extent that he can get B to do something that B would not otherwise do" (Dahl 1957: 202-203). The other perspective conceives power as not having to obey. This perspective has been emphasised

[2] We use 'medium' here in the basic sense that it operates 'in between' different actors. The term medium connects to our theoretical frame, in which influence in society is facilitated through different forms of "generalized media" (Parsons 1963a). In line with STS, we do not conceive technology as a neutral medium, but as having a transformative capacity in social relations (Sayes 2014).

by Crozier and Friedberg (1980), who linked the opportunity of not having to obey to the control of a relevant zone of uncertainty.

Both perspectives have in common that they use the concept 'power' in an encompassing sense, i.e. as including all ways of changing an actor's behaviour or means of resisting such an attempted change. This broad use of the concept of power in sociology entails a "conceptual diffuseness" that has already been criticised by Parsons (1963b).

> "The effect of this diffuseness, as I call it, is to treat 'influence' and sometimes money, as well as coercion in various aspects, as 'forms' of power, thereby making it logically impossible to treat power as a *specific* mechanism operating to bring about changes in the action of other units, individual or collective, in the processes of social interaction." (Parsons 1963b: 232, emphasis in original)

As an alternative, Parsons proposes to conceptualise power as one of three "general mechanisms" or "generalised media" of social interaction through which an actor's behaviour can be changed (Parsons 1963a). Power is placed beside influence and money.

The idea of analysing attempts by actors to change other actors' behaviour in terms of several distinct ways of interaction has recently been taken up by Schimank (2010). Schimank deviates from Parsons by using "influence" as the overarching concept for altering behaviour. He defines influence as the implementation of a behavioural expectation against the interests of the expectation's addressee (we would add: if necessary), and distinguishes several kinds of influence (ibid: 267-304). Among these influences, 'power' is determined as coercion (influence based on force). In a scheme that reduces the kinds of influence to three, Gläser and Schimank (2014) complement power by inducement (influence based on resources) and persuasion (influence based on knowledge or values).

For our purposes, Schimank's approach has two advantages. First, while Parsons (1963a) associated specific generalised media with positive sanctions (money) and negative sanctions (power), Schimank suggests that all kinds of influence can be used for initiating and deterring human behaviour. Second, Gläser and Schimank distinguish two modes in which influence is exercised, namely influence through interaction and influence mediated by structures (Gläser and Schimank: 46). An actor can interactively influence others by e.g. issuing orders, providing or withdrawing rewards, or convincing them. The influence is structurally mediated if actors exercise influence by setting up rules of behaviour, designing reward procedures, or creating other structures.

The distinction between influence through interaction and influence through structures provides the opportunity to introduce a third mode of, namely technologically mediated influence.

This mode is similar to mediation by structures but sufficiently different to warrant separate consideration.

Our decision to position technology-mediated influence alongside structurally mediated influence rather than subordinating it as a specific case is based on the insight of STS that the materiality of technology makes a difference. If this is the case, subordinating technological to social structures obscures the conditions and consequences of exercising influence through material technology. We do not have to follow STS's more radical arguments concerning the role of technology in order to apply this important contribution by STS to sociological theory. The three positions concerning technology that are currently discussed in STS are ANT's symmetrical position (Callon 1986; Latour 2005), Latour's (1991a) argument that material obduracy makes technology the primary factor that stabilises society, and a position assuming supremacy of social structures (Pinch 2008). These three positions have in common that they need to consider technological structures as *distinct from* social structures. Two important aspects of this distinctness are the materiality of technological structures and their existence independent of actors, which makes a difference at least in some social theories.

Such a parallel treatment of material technological and social structures has been debated for a long time. The problem can be traced back to the emergence of sociology as a discipline, which required to defend the status of social causes against arguments that ascribed social differences to psychological, biological, or climatological factors (Grundmann and Stehr 1997: 87-91). In their fight for a space for sociology among the disciplines, "the classical sociologists 'excluded' the physical environment." (Grundmann and Stehr 2000: 159). This observation was extended to material aspects of technology (Rammert 1998).

Emphatically objecting to theoretical purifications that only consider social facts and thus disregard the material features of social order, sociologists and historians of technology argued that social order and dominance are inherently articulated through material artefacts (Mumford 1964; Linde 1972). Latour emphasised this interconnection between technology and society in his famous statement that "technology is society made durable" (Latour 1991). Latour did not simply equate social and technological structures based on their durable and constraining features but argued that social structures are made durable by the material base technology provides. While there is no complete agreement between these scholars, there are two common threads in their arguments. First, social order is at least partly created through technological structures. Second, it is created through technological structures in a particular way due to the structures' materiality.

This perspective is both crucial and contested with respect to social theory, as Orlikowski (1992; 2000) has argued in a precise application of structuration theory to the question of

technology, materiality, and structure. In structuration theory, (social) structures do not exist outside of human doings. They have to be enacted in order to be realised, which means that they are denied an independent existence outside of practice. If this approach to social structures is extended to technological structures, technologies must also be denied a capacity of embodying social structures in order to curtail a possible independent existence outside of practice. Orlikowski opts for this position by emphasising that structures should rather be seen as emergent from practice than as embodied in technologies. The conceptual appeal of this argument lies in the opportunity to position technology in social theory and opening up the use of technology to sociological analyses based on structuration or, more general, practice theory. However, these analyses are limited by enforcing the neglect of any intentional exercise of influence through technology. A contrasting position to Orlikowski would effectively entail stripping technologies of their materiality. This approach has the similar advantages of increased compatibility with social theory but comes at the price of an indistinguishability of technical and social structures or even the disappearance of technological content in favour of social structures (Button 1993). This approach severely limits the possibilities to deal analytically with the role of technology's materiality, which has become untenable because STS has demonstrated that the materiality of technological structures makes a difference in human action. Taking technology into social theory thus easily leads into a conceptual dilemma. On the one side, technology cannot embody structures, because they have to be enacted in practice. On the other side, the structures can be simply detached from technology, because of their immaterial nature. Both sides struggle with the problem how materiality and structures are related in technologies and how this can be distinguished from "pure" social structures.

The non-reducibility of technological to social structures argued by STS motivates our suggestion to introduce technologically mediated influence as a third kind of influence beside interaction and influence mediated by social structures. If it is the material specifics of how technologies are used to generate social order and how this order might be disobeyed, a specific approach to comparative studies of technologically mediated influence is necessary. Here we must note that we are not concerned with proposing a general definition of technology with respect to social structure, as Orlikowski does. We are interested specifically in technologies which are used as modes of influence and how this influence is achieved through material qualities.

2.2 Positioning technology as a mode of exercising influence

If technology is a non-reducible structure through which exercise can be influenced, technology-mediated influence should be positioned alongside social structures as a distinct mode of influence

(Table 1). We start from Schimank's distinction of three kinds of influence and the cross tabulation of kinds and modes of influence suggested by Gläser and Schimank (2014). From these suggestions, we construct a cross tabulation of three kinds of influence with an interactive, a structurally mediated, and technologically mediated mode of influence. Adding a technologically mediated mode of influence also made us notice slight inconsistencies in the work we build on, which made us reformulate some of the concepts.

		Kind of influence		
		coercion	*inducement*	*initiating re-interpretation*
Mode of influence	*Interactive*	Order	Reward	Communication
	Mediated by structures	Prescriptive rules	Arranged reward procedures	Arranged belief systems
	Mediated by technology	Material restraint	Materially programmed rewards	Materialised provision of information or references to values

Table 1 Kinds and modes of influence

Coercion is defined as influence based on force. However, the actual exercise of physical force remains a background threat in the overwhelming majority of interactive and structurally mediated coercion. People follow orders or prescribed rules for a variety of reasons. They may follow orders or rules as a matter of routine, because they believe them to be legitimate or necessary, because rule-following frees them from the necessity to make a decision, or because they know that force may be applied if they do not comply. Force may be applied, e.g. when people are physically restrained (imprisoned) because they broke rules (laws). This actual application of force remains an exception, however, because people are successfully influenced by orders or prescribed rules.

In contrast, physical force comes directly into play in technologically mediated coercion because technology can exercise physical influence. For example, a turnstile can physically prevent customers without ticket from traveling, while a rule against free riding on public transport makes travel without ticket possible but would result in a penalty to be paid (with the payment ultimately being enforced by law).

The second kind of influence, inducement, differs from coercion in that it is symmetrical and more manifest. It is symmetrical because rewards can be provided or withdrawn. Rewards also have to be provided or withdrawn in order to influence behaviour. The mere promise respectively

threat to do so has limited effects. Rewards include physical rewards such as pleasure, material rewards such as resources and, most frequently, money, and immaterial rewards such as recognition or information. They can be used interactively or through arranged procedures such as competitions for a reward or a performance-based pay scheme.

Reward procedures can also be materially programmed. A common example for negative inducement through technology would be an alarm clock that is becoming louder if the user does not switch it off. Another example are the many computer games that reward successful players with 'boni'. This example also illustrates why programmed reward procedures are largely linked to information technology. For this mode of technologically mediated influence to operate, the user's behaviour must be monitored and a feedback must be programmed.

The third kind of influence was called 'persuasion' by Schimank and was excluded from the cross tabulation by Gläser and Schimank (2014) because it played no role in their discussion of autonomy. We renamed this kind of influence as initiating re-interpretation in order to express more clearly what it does, namely providing information that makes actors re-interpret their situation and change their goals accordingly. More precisely, the information provided is intended to change links between an actor's knowledge and values, e.g. by informing them that smoking endangers their (highly valued) health or by making actors aware of links between their knowledge about a situation (e.g. a natural disaster) and their values (e.g. solidarity).

The examples illustrate that a re-interpretation does not change an actor's situation but only the way in which the actor sees it. This re-interpretation is initiated by the provision of information, which can occur interactively by communication. The structures mediating the initiation of re-interpretation consist of arranged links between knowledge and values in belief systems. Technologically mediated persuasion occurs with any materialised provision of information, which range from simple signs telling people not to swim in a river because it is infested with crocodiles to recent information technology that provides information about its user's exercise and calorie intake.

The three kinds of influence do not operate separately and often cannot be as easily distinguished as the ideal types in Table 1 suggest. For example, superiors will try to convince their subordinates and only resort to giving orders because the former causes much less social tension than the latter. The argument will, however, be made in the shadow of a hierarchy that ultimately rests on force. Both actors know that issuing an order is possible, which implicitly or explicitly shapes the argument. Another hybrid case is the communication of information, which can function as a reward in an inducement or as information in a persuasion. Similarly, the three modes of

influence overlap in the exercise of influence, e.g. when orders refer to rules or communication includes references to belief systems or technologically stored information.

The discussion of technologically mediated influence as a specific mode that exists for coercion, inducement and initiating re-interpretation demonstrated that the mediation of influence through technology is both sufficiently consistent and sufficiently different from structurally mediated influence to warrant its introduction as a distinct mode. However, an interesting peculiarity of technologically mediated influence should be mentioned. The case that is included as a possibility in the definition of influence - that the implementation of behavioural interests does not contradict the interests of the addressees – is common and even predominant in technologically mediated influence. For example, the Berlin key analysed by Latour (1994) implements behavioural expectations only against the interests of those users whose interest is not to lock the door behind them, while its influence coincides with the interests of all users who want to lock the door behind them anyway. More generally, most users want to use a technology for the purpose for which it was designed in the ways intended by the designer, and are only influenced against their interests when these interests suggest a mode of use that deviates from that purpose. However, we consider the specific case of influence against the interests of the user as a useful model situation from which dimensions for the comparative description of technology can be derived.

2.3 Technologically mediated influence is exercised through scripts

How can the mediation of influence by technology be analysed? We think that the concept 'script' is best suited to the task. The concept has been introduced in STS in the early 1990s (Akrich 1992).[3] It addresses one of the field's main concerns, namely the conceptualisation of the agency of artefacts in situations of distributed action. Akrich's notion of the script draws on the semiotic ANT model of material agency and inscriptions developed by Callon (1986), Latour (1987) and Woolgar (1991), where de-, pre-, trans-, con-, or pro-scriptions of many kinds have been used to analyse the complex interrelations of humans and non-humans in ANT (Akrich and Latour 1992).

Creating a script means shaping the materiality of an artefact in a way that specifies how it is to be used for a particular purpose. The effectiveness of this prescription is due to the artefact's material features. This relationship lies at the heart of all possible ways of speaking of an artefact's agency (or the distribution of an action between human actor and artefact). The artefact's

[3] Our notion of scripts focusses on scripts that are incorporated in technologies in order to shape actions. It does not extend to cognitive notions of scripts as "knowledge of stereotyped event sequences" (Abelson 1981: 715) or as "cognitive organization" (Fulk 1993: 922) nor to other sociological notions of scripts as "behavioural regularities" (Barley and Tolbert 1997: 98) or as widely shared "scripts for activity" (Meyer and Jepperson 2000: 111).

materiality makes it possible for designers of scripts to exercise influence on unknown others across space and time. The concept 'script' thus links designers, users and use situation:

> "Designers (..) define actors with specific tastes, competences, motives, aspirations, political prejudice, and the rest, and they assume that morality, technology, science, and economy will evolve in particular ways. A large part of the work of innovators is that of 'inscribing' this vision of (or prediction about) the world in the technical content of the new object. I will call the end product of this work a 'script' or a 'scenario'. The technical realization of the innovator's belief about the relationship between an object and its surroundings actors is thus an attempt to predetermine the setting that users are asked to imagine for a particular piece of technology and the pre-scriptions (notices, contracts advices, etc.) that accompany it. (...) Thus like a film script, technical objects define a framework of action together with the actors and the space in which they are supposed to act" (Akrich 1992: 208).

According to this definition, the material inscription is not only a programme of action that is pre-defined and materialised but also prescribes the possibilities of use (and thus of user behavior), the basic features of use situation, and not least the user herself.

Akrich advices caution not to understand scripts in a deterministic way (ibid). We see three specific reasons the use of technology often deviates from scripts. First, assuming that a script's prescription is identical to later user behaviour reduces the material arrangements to mere instrumental means to human ends, thereby neglecting the ways in which the means-at-hand contribute to shaping the ends-in-view of users (Dewey 1939: 33-50). Second, it underemphasises the subversive power of users in processes of adoption and appropriation (Oudshoorn and Pinch 2003). Third, a technology's scripts are rarely unequivocal. A technology usually contains multiple scripts, which address different interactions with devices and may be more or less overt (Jarzabkowski and Pinch 2013).

These three limitations must be taken into account when the use of technology is studied. For the purposes of our analysis, we nevertheless take scripts as representing influence, namely the attempt to change behaviour. That these attempts are successful only to a limited extend is not a peculiarity of technological scripts but something they have in common with interactions and social structures. Still, for a study of technologically mediated influence it is not necessary that scripts always exercise the influence successfully. The common use of most technologies routinely executes their scripts, which is sufficient for our purposes.

The concept of scripts is not new in STS but its potential has not yet been fully developed. A 'script' links several types of actors including a principal/sponsor, the designer, producers, in some cases actors implementing the technology, and users of technological artefacts. Linking actors in a specific way makes technological artefacts constitutive elements of social order. We take this cue from ANT but see the need to move beyond a reiteration of the argument that materiality does

matter by developing a comparative framework that captures how technological agency is realised differently in specific circumstances.

2.4 Dimensions of influence and a comparative framework for scripts

The positioning of technology in social theory as a mode of influence enables the application of the sociological repertoire to the task of constructing dimensions in which technologies as media for influence can be compared. We analyse the material inscription of user behaviour in a technology as a constellation of influence and derive dimensions from a sociological approach to the description of such constellations. The elementary situation in which influence is exercised – ego influences alter – varies in several dimensions, which describe the two actors, the process of influencing, and the situation in which the process is embedded. Table 2 details these dimensions for influence in general and specifies them for the comparison of scripts. Owing to the complexity of constellations of (technologically mediated) influence, the dimensions have nominal scales of different states rather than ranks or quantitative values.

To illustrate these dimensions we introduce an interpretation of the well-known case of the Berlin key, which was used by Latour to illustrate the ability to create a specific social order via the design of a simple artefact (Latour 2000). The design of the key and the corresponding lock forces tenants to lock the door of the house behind them – they are only able to remove the key after they locked the door (Figure 1). Users unlock the door, slide the key through the keyhole, pass through the door, turn the key again (thereby locking the door again) and only then are able to retrieve it.

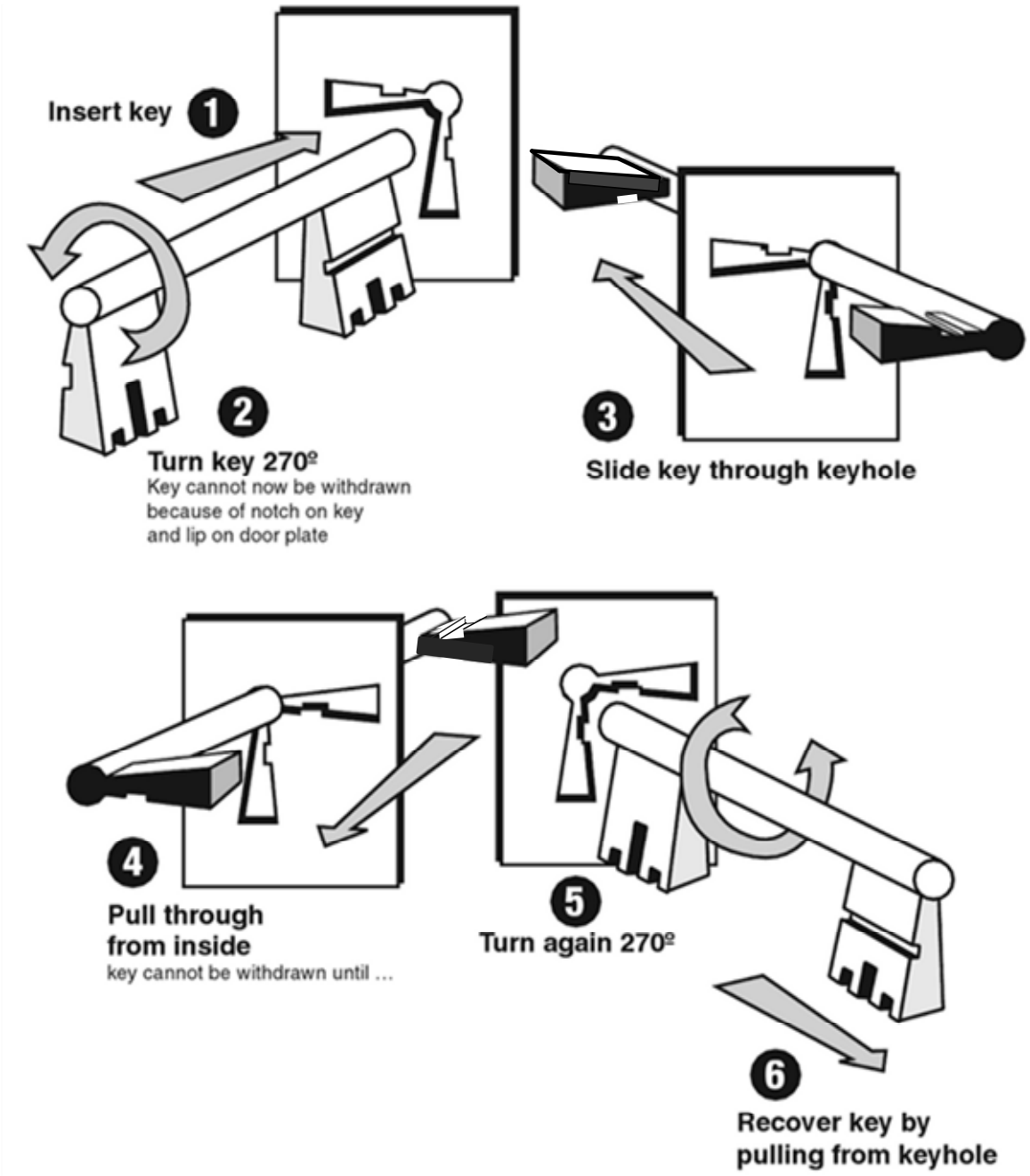
Insert key
1
2
Turn key 270º
Key cannot now be withdrawn
because of notch on key
and lip on door plate
3
Slide key through keyhole
4
Pull through
from inside
key cannot be withdrawn until …
5
Turn again 270º
6
Recover key by
pulling from keyhole

Figure 1 Berlin key and instructions for its use (source: adapted Figure 1.5. and 1.6 from Latour 2000: 15-16)

Dimensions of influence	*Dimensions of scripts*	*Application to Berlin key*
Addressees (properties of actors that make them targets of influence)	Inscribed definition of user-group Accessibility of technology to different kinds of users	User group: Tenants (perceived as unreliable by house owners) Tenants trained in key use
Influencing actor (specificity of aims)	Specificity of purpose of technology	Highly specific purpose: Key use should effect closed door
Kind of influence (enforcement-inducement-persuasion) and strength	Kind and strength of influence utilised by script	Strong enforcement: Tenant is forced to close the door in order to keep the key
Specificity of behavioural expectations	Distribution of control over actions between user and artefact - flexibility of intended use	Control over action resides in Berlin key: no flexibility of use
Dynamics of influencing	Homogeneity of distribution of control across script	Patterns are homogeneous: every single step of using the key is completely determined by the design of the key-lock-system
Perceptibility of influence by addressees	Visibility/Opacity of script and its purpose for users	Script is highly visible because it is realised in the material form of the key-lock-system But only for skilled users, not telling for novices
Situation in which influence is exercised	Material aspects of the situation Embeddedness in larger scripts	Script is a completely (and beyond possible dispute) mechanically realised part of the situation (form of notch and lip) Absence of alternative access (design and location of doors)

Table 2 Aspects of influence, dimensions of scripts and application to the Berlin key case

The first dimension in which the exercise of influence, and thus scripts, can be compared derived from the relational nature of influence as being based on ego's behavioural expectation concerning alter. The *addressee of a behavioural expectation* is one of the fundamental features of a relationship of influence. In the case of influence through scripts, the addressees are those users of a technology that are to be influenced. Similar to preconditions set by structurally mediated influence (scope of rules, participants in competitions, or accessibility of systems of knowledge

and values), technology targets some users but not others. In the case of the Berlin key, the user considered is the person who needs to pass the door (the tenant). Tenants were perceived to be unreliable and frequently not to lock the door behind them, which is why they were given a special key. These users also need to know how the key has to be used/utilised.

A second dimension describes ego's aims concerning the behaviour of alter. The exercise of influence varies in the *specificity of these aims* that are to be achieved. The actor exercising influence may aim at a very specific outcome or at a rather broad range of effects. This dimension translates into the specificity of a technology. The specificity of the Berlin key's purpose is very high because its only purpose is to create a situation in which the door is locked after its use.

The third general dimension in which influence and thus scripts can vary is the *kind and strength of influence*. Kind and strength of influence are linked in a complex, non-hierarchical relationship. We would generally expect that coercion is a stronger influence than inducement, and inducement in turn stronger than initiating re-interpretation. However, the re-interpretation of a situation achieved by a belief system, e.g. of a religious cult, can produce an influence that is at least as strong as that achieved by coercion. We already demonstrated that all three kinds of influence can be inscribed in technology, which would then force users to behave in a particular way, reward them for such behaviour, or convince them that this behaviour is appropriate. The Berlin key is a clear example for influence via strong enforcement: The shapes of key and lock simply force key users to lock the door if they want to keep the key.

The fourth dimension describes *the specificity of the way in which the situation can be produced*. The exercise of influence varies in the extent to which the actions of the addressee are specified. This is different from the second dimension because the aim may be highly specific but may be achieved in different ways (all roads lead to Rome). In the case of scripts, this dimension can be specified as the *distribution of control* over actions between the user and the technology because the distribution of control determines the flexibility of use. Technology may achieve its purpose only if the user exactly follows the script, it may 'tolerate' deviations from the script by users, or it may even require input from the user because the script cannot be fully specified in advance. The distribution of control inscribed in the Berlin key is one-sided and resides in the key. Users have no control over the way in which the key is used, which makes the key use very inflexible. If key users want to pass the door and take the key with them, they need to execute the script precisely as described in Figure 1. Thus, the range of a key user's possible actions is highly restricted.

The strength of influence can vary in the course of influencing - be it interactive, structurally mediated or technologically mediated. This possible variation is captured by the dimension

dynamics of influencing If the exercise of influence is not just an event but extends over time, the strength of an influence (and thus the addressee's control over their action) can vary. Examples include occasional interventions of supervisors in the case of interactive influence and procedural rules that contain decision points for those following them. For technology, we specify this dimension as the distribution of control between technology and user over time, e.g. the *homogeneity* of that distribution across the script. In the case of the Berlin key, control is homogenously distributed and lies with the artefact throughout the execution of the script. In contrast, computer programs may ask the user to make decisions, thereby creating phases in which the user is active, followed by phases in which the user cannot interfere with the program. Such a phased script can also be constructed by spatial arrangements. A common example are IKEA stores which contain a path customers have to follow but also can cut short at certain points.

The exercise of influence also varies in its *perceptibility by addressees*. Addressees might not recognise that they are influenced, might recognise it when it is too late, or might not recognise the influencing actor. Such a low perceptibility or opacity of influence is more likely when influence is structurally mediated, which already points to the opportunity to obscure influence by technology. The scripts of a technology may be more or less *visible* to the user. Users often know that they are scripted and what behaviour is expected of them when interacting with a technology. However, scripts may also be made invisible to the user in order to make users induce a specific behaviour that the user does not recognise or recognises too late. The visibility of the Berlin key's script and its purpose for the user depend on user skills. Skilled users can easily see every detail of the script because it is materialised in the key's form. However, for an unskilled user (like the anthropologist in Latour's own description) the functioning of the Berlin Key is completely opaque. The script and the influence it has on the user, then, can only be perceived as inability to use the key at all, which makes it impossible to leave the house at night.

A final dimension that must be taken into account by a comparative approach to influence is the embeddedness of influence in a more complex *situation*. Addressees of influences act in situations that are shaped by overlapping influences and other conditions of action. This situation contributes to shaping each individual influence. In the case of technologically mediated influence, this means that in addition to other actors and structurally mediated influences, particular attention must be paid to *material properties of the situation* in which a technology is used. For the Berlin key, the script is a completely mechanically realised part of a mundane micro-situation: The Berlin key (with its lip) functions exclusively with doors that have a respective locking mechanism and shape of the key hole (with its notch). Leaving the house and locking the door is only possible via a series of actions prescribed by form of notch and lip of the keys and form of the lock-system.

This of course has prerequisites in the larger surrounding of the situation: The script's influence on key users depends on the existence of alternative ways of leaving or entering the house.

3. Applications

To illustrate the potential of our comparative approach, we apply it to two discussions of technologically mediated influence. First, we explore the dynamic relationship between inscribed and user influence by comparing types of 'persuasive technologies'. Second, we ask how the increasing sophistication of technologies affects the autonomy of users. The comparisons of technologies in the two applications illustrate the potential of our approach to link analyses of technologies to each other and to guide empirical comparative studies.

3.1 Making sense of "persuasive technologies"

The fields of Human-Computer Interaction and Software Design also begun a discussion about the exercise of influence through computer systems. As in the techno-regulation debate, different forms of influence are distinguished. Fogg (2003) has drawn together several strands of this debate in a systematic account of "persuasive technology", which he defines as "interactive computing systems designed to change people's attitudes and behaviors" (ibid: 1). Research on these technologies should, according to Fogg, focus "on endogenous intent, that is, the persuasive intent that is designed into a computing product" (ibid.: 17). This matches with the STS concept of scripts, although Fogg does not seem to know this research tradition.

Fogg distinguishes between two approaches to behavioural change, namely persuasion and coercion: "It's important to note the difference between *persuasion* and *coercion,* terms that are sometimes confused. Coercion implies force; while it may change behaviors, it is not the same as persuasion, which implies voluntary change – in behavior, attitude, or both." (ibid: 15).

Among the persuasive technologies, Fogg distinguishes seven types. The basic understanding underlying the typology of persuasive computing technologies is a general assumption about how the designer's intentions can be transferred into a technological incentive for the users: "The research on intrinsic and extrinsic motivation shows that the gentler the intervention to achieve the desired behavior change, the better the long-term outcome" (ibid.: 54). This abstract notion of "gentleness" appears to be the dimension in which the types are distinguished. Unfortunately, this abstraction removes the properties of the technological designs from the comparison. More importantly, Fogg's statement and typology suggest that in order to comparatively analyse technologies' impact on behaviour, it is sufficient to project their complex properties on just one dimension.

We test Fogg's implicit hypothesis by applying our comparative approach to his types of persuasive technology and the corresponding empirical examples (Table 3). All technologies are widely accessible to users because they are intended to change everyday behaviour. The specificity of the technologies' purposes is also high for all seven types. However, we find important variation in the kinds and strength of influence utilised by technologies belonging to the seven types. The "persuasive technologies" discussed by Fogg utilise all three kinds of influence. "Reduction technology" reduces the number of steps that must be taken to reach a goal. One-click shopping is a reduction technology that enables the user to pay by credit card and initiate delivery by just one click of the computer mouse because all other necessary steps (e.g. confirming mode of payment, decisions on billing address and delivery address, decision on mode of shipping) are pre-programmed and will be made automatically. This is much easier than pursuing these goals without reduction technology. Thus, reduction technologies are cases of inscribed inducement, which is widely accessible, highly specific, and visible. The control of the action is largely inscribed, too, and the script is homogenous. Once the user triggered the technology, they yield control to it. Reduction technologies are usually part of larger scripts and simplify certain steps of those.

In contrast, "tunnelling technology", defined as "leading users through a predetermined sequence of actions or events, step by step" (ibid.: 34), clearly uses coercion in both our and in Fogg's understanding of the concept. For example, a software installation programme requires decisions and inputs from the user at some defined points but inevitably guides the user to a highly specific outcome – the software is installed, user information is transmitted to the firm providing the software, and so on. The user can follow the steps of the script and reach the goal, or quit the script and abandon the goal. The user "becomes a captive audience. If users wish to remain in the tunnel, they must accept, or at least confront, the assumptions, values, and logic of the controlled environment" (ibid: 36). The scripts have highly specific purposes and are heterogeneous in that phases of user inputs, followed by phases in which the technology controls the process. Tunnelling scripts are often intransparent and part of larger scripts.

"Tailoring technology" provides information tailored to the interests of individual users (see ibid: 37pp). An example is the website http://aqicn.org, where users can obtain information about the air pollution in their city. The information is 'tailored' to their location. The type "suggestion technology" is a more specific version of this, namely "an interactive computing product that suggests a behaviour at the most opportune moment" (ibid: 41), i.e. in a very specific situation. An example of suggestion technology are speed meters that show drivers their actual speed, thereby providing them with information that might make them adhere to the speed limit. Tailoring and suggestion technologies have in common that they inscribe an initiation of re-interpretation because

the technologies do nothing except providing additional information for the specific situation of use as opportunities or possible choices unknown to the user without the technological augmentation of information at hand. The specificity of purposes inscribed may vary. The technologies are homogenous in that the control lies with the technology. Users may select which information they want to receive, but beyond that they have no influence on the measurement process, which is often opaque to them.

"Self-monitoring technology" – e.g. a bracelet that shows users their current heart-rate - does not only provide information but also an incentive: "The goal is to eliminate the tedium of measuring and tracking performance or status" (ibid: 44). The heart rate monitor induces the users because it allows them to adapt their exercise level to a target heart rate. Thus, "self-monitoring" combines initiating re-interpretation with inducement. The technologies are often highly specific and control most of the action. They are, however, heterogeneous because the user has choices concerning the configuration of measurements.

"Surveillance technology" is defined by Fogg as "any computing technology that allows one party to monitor the behavior of another to modify behavior in a specific way" (ibid: 46). In the example of the HygieneGuard, a technology which monitors the time of employees spent with washing hands after using the toilet, according to Fogg is effective simply because the employees know that they are surveilled and this "„increases the likelihood of a desired outcome" (ibid: 46). 'Users' of the technology are watched and change their interpretation of the situation – it is no longer a private one. This initiation of re-interpretation is utilised in a situation of rule-based coercion.[4] The surveillance technologies discussed by Fogg are highly specific – they target just one type of 'user' behaviour. They are also homogenous and leave the 'user' with no possibility to control. Their effect depends on the script's visibility (which is different for other surveillance technologies). The technologies are widely 'accessible' because

[4] This embeddedness of surveillance in situations of coercion points to an aspect of technologically mediated influence we already mentioned (see above, section 2.3), namely the necessity to distinguish between kinds of users. The distinction between users who implement a technology and users who are just subjugated to it is of particular importance when surveillance technologies are discussed.

Dimensions of scripts	*Reduction (e.g. one-click shopping)*	*Tunnelling (e.g. software installation)*	*Tailoring / Suggestion (e.g. tailored commercials)*	*Self-Monitoring (e.g. heart rate monitor)*	*Surveillance (e.g. workplace surveillance)*	*Conditioning (e.g. rewards in computer games)*
Accessibility of technology to different kinds of users	Widely accessible to computer users	Widely accessible to computer users	Widely accessible to computer users, limited choice concerning interaction	Widely accessible to users	Widely used, limited choice concerning interaction	Widely accessible to computer users
Specificity of purpose of technology	High – one specific intended outcome	High – one specific intended outcome	Varies from supporting a wide range of choices to eliciting specific actions	Often high – one specific kind of information provided	High	High – one specific intended outcome
Kind and strength of influence utilised by script	Inducement	Coercion	Persuasion	Initiating re-interpretation Inducement	Initiating re-interpretation	Inducement
Distribution of control of actions between user and artifact – flexibility of intended use	Most of the action is controlled by technology	Most of the action is controlled by technology, user has predefined choices	Controlled by technology	Most of the action is controlled by technology, user has predefined choices	Controlled by technology	Most of the action is controlled by technology
Homogeneity of distribution of control	Heterogeneous (user action followed by action of technology), collapsed into two steps	Heterogeneous – limited choices by users intersperse operation of technology	Homogenous scripts, addressees have no choice	Heterogeneous – limited choices by users intersperse operation of technology	Homogenous scripts, addressees have no choice	Heterogeneous (user action is 'rewarded' by technology)
Visibility/ Opacity of the script and its purpose for users	Visible	Script often invisible	Often opaque	Mostly transparent	Visible	Visible
Material aspects of the situation, embeddedness in larger scripts	Used to simplify steps in larger scripts	Used to force user through steps in larger scripts	Integrated by users in their situations Situation-specific high-specificity tailoring is *suggestion*	Embedded in plans to change own behaviour	Embedded in situations of structurally mediated coercion	Used in larger scripts for changing user behaviour (inscribing of changed behaviour in users)

Table 3: Comparison of Fogg's persuasive technologies

'users' don't have a choice about 'using' them.

The type "conditioning technology" is defined as a "computerised system that uses principles of operant conditioning to change behavior" (ibid.: 49) or as "computing technology [that uses] positive reinforcement to […] transform existing behaviors into habits" (ibid.: 53). The technologies use inducement by providing programmed rewards for specific types of behaviour. They are widely accessible and highly specific. In most cases, a very specific action of a user is rewarded. Scripts are heterogeneous in that users need to perform operations in order to be rewarded by the technology. However, the control lies mainly with the technology. The script needs to be visible in order to be effective. It is important to stress here that conditioning technology is used to permanently change user behaviour by creating habits or even addictions, in other words: to *inscribe* a specific behaviour *in users*.

Our comparison shows that linking the effectiveness of persuasion technologies to "gentleness" is a rather strong reduction of complexity and might not lead to a sufficient understanding of what persuasion with computer technologies does. Applying the dimensions for the comparison of scripts can clarify and conceptually deepen the understanding of the principle mechanisms that enable the exercise of influence on users via the design of technology. Furthermore, applying the dimensions of scripts clearly reveals that the concept of "persuasive technology" is multidimensional in principle.

3.2 Increasing levels of activity and the distribution of influence: Airport security technology[5]

The rapid development of technology and particularly information technologies is reflected in the sociology of technology by references to increasing "degrees of sophistication", "autonomy", "agency", or "level of activity" of technology. However, there is no agreement on the consequences of these trends for human actors. On one pole of the spectrum there is the position that increased sophistication narrows the room of manoeuvre of human actors. For example, in their study on the governance of a container terminal, Weyer and Cramer conclude:

> The increasing autonomy of technology corresponds to a change in the status of the human actor. The opaqueness of processes constrains the ability of human actors to implement their strategies by exploiting options and rooms of manoeuvre provided by technology. The human actor becomes the passive observer of a system which he understands less and less well. He must adapt his behaviour to the machine and is increasingly forced into passive-reactive, adaptive behaviour. (Weyer and Cramer 2007: 279, our translation)

This position is also often voiced in held surveillance studies (e.g. Introna and Wood 2004). On the other pole of this spectrum, increased sophistication of technology is seen as widening the scope

[5] This section draws on a comparative empirical study of security technologies (Schäufele 2017).

of human action. For example, Rammert introduces a conceptual distinction of consecutive "levels of technical agency", namely "passive", "semi-active", "re-active", "pro-active" and "co-operative" (Rammert 2008: 69) and claims:

> „The higher the inherent level of agency of technological elements, the more the relation between humans, technical means and signifying objects shifts from simple instrumentality to manifold interactivity" (Rammert 2009: 26, our translation)

These very general arguments come with little, if any, empirical substantiation. This is not surprising because empirically linking degrees of sophistication or levels of technical agency to the range of possible actions of users would require systematic comparisons of a larger number of technologies, for which there is no methodological support. We test the fruitfulness of our framework by comparing three airport security technologies which have a similar purpose, namely detecting dangerous objects: the Walkthrough Metal Detector, the X-ray scanner for luggage, and the relatively new technology of the body scanner.

We focus our analysis on the airport security personnel who daily operate these machines as users whose behaviour is scripted. The behaviour of passengers is scripted to some extent, too – they have to move through the machines or handle their luggage in specified ways. However, their status vis-à-vis the technology is closer to that of an object than a user. Security officers check luggage and passengers by operating security technologies. These technologies provide certain information and indicate a certain action, which are prescribed as mandatory by the rules that are part of the sociotechnical arrangement in which the technologies are embedded.

Walkthrough Metal Detectors at airports were designed to search for concealed metal weapons on a person's body. Built like a door, with sensors in the frame, detectors raise an alarm if metal of a certain specified amount or density comes near the sensors. The alarm consists of a sound and a visual indicator (a small display with red and green LED lamps). The machine's signal induces a very clear action, namely manual checking of the passenger by the security officer. The script consists of a 'ready' signal by the detector, followed by the security officer's invitation for a passenger to walk through the detector and a manual check by the security if the detector gives a signal.

X-ray luggage scanner at airport security checkpoints are used to check unopened pieces of hand luggage. All items that pass through the scanner are screened and a multi-coloured image of the luggage is produced and displayed to the user. Orange indicates organic, green non-organic, and blue very dense materials (probably metal, hard plastic or alloy). This image needs interpretation by the scanner's user. Therefore, the security officer analyses the image for being 'suspicious' or 'dangerous' and marks them as 'needs follow-up check by hand' and thus induces further actions. If the picture is ambiguous, the security officer has the opportunity to move the belt

backwards and re-scan the luggage. In contrast to the Walkthrough Metal Detector, the luggage scanner has no inscribed selection of things 'suspicious' or 'dangerous'. Rather it is a shared activity: the machine provides a signal (a detailed image), this signal must always be interpreted by a human.

The *Body Scanner* has similar functions as the Walkthrough Metal Detector, namely finding dangerous objects on a person's body. It produces a whole-body image of passengers in order to detect any object that is not part of the human body. The user first must provide an initial input about the basic form of the human body to be analysed - male or female - so that the machine knows the underlying norm of its calculations. When it is ready, and a person is invited in, the machine analyses the scan data and generates an abstract image of the person. In contrast to the luggage scan, the analysis occurs completely autonomous. The final output consists of an abstract picture of a human body, on which red markings indicate where potentially dangerous objects were detected.

The three technologies vary in their degree of sophistication and their levels of technical agency: The metal detector just visualises a sensor signal, the X-Ray luggage scanner provides an image that is then analysed by a human operator, and the body scanner visualises a sensor signal, analyses the image and provides an interpretation. In terms of Rammert's levels of agency, the metal detector is semi-active, the X-Ray luggage scanner is re-active because it uses images as input in a feed-back loop, and the body scanner is pro-active because it uses automated image analysis. For a further comparison of the three technologies we utilise the script dimensions developed before (Table 4).

The *accessibility* of all three technologies is restricted to authorised personnel, namely the security staff at the airport. However, the technologies differ in the skills of the users that are necessary for operating the technologies. While the Metal Detector and the Body Scanner require only minimum skills, the X-ray Scanner demands a higher level of training. Users must learn how to interpret the X-ray images.

The *purpose of the technology* is highly specific for all three technologies in that dangerous items need to be detected and removed from the secured area. The *kind of influence* exercised is initiating re-interpretation in all three cases. The technology produces an output that can be translated into simple decisions about subsequent actions. The strength of the influence varies because the information provided is linked to different rules in the socio-technical situations (see below).

The *distribution of control of action* again varies between the three technologies. Users of the metal detector and the body scanner have very little control. Their actions are restricted to pushing buttons. In contrast, the X-ray machine gives its users significant control because they decide (after

the interpretation of the image) whether to re-scan the luggage, let it pass, or direct it to additional checks. Correspondingly, the *homogeneity of distribution of control* is high for the metal detector and for the body scanner because in both cases users only start the technology and respond to its signals. In the case of the X-ray machine, control oscillates between the user and the machine because after interpreting the image, the user can initiate a re-scan or decide that further action is necessary depending on the image provided by the machine.

All three scripts are *transparent* insofar as the technology's purpose is straightforward and clear input-output relations exist. However, certain elements of the configuration are opaque. The Walkthrough metal detector disguises the level of sensor sensitivity. The luggage scanner contains 'false images' that are included by superiors to test the actions of their security staff. The body scanner is opaque in terms of the automated image analysis.

The *material aspects of the situation* concern only the body scanner, whose correct functioning depends on passengers to conform to body norms concerning sex, height and corpulence, which are inscribed into the automated analysis of the scan data. An important aspect of the three technologies' embeddedness in larger scripts is the institutional context of airport security. The airport security regime defines strong obligations for all passengers to pass the checks. With regard to the airport security personnel in their role as users of the three technologies, coercion, occurs as a combined effect of technology and the institutional setting in which it is embedded. The obligation of always taking action in response to specific signals produced by the machines is inscribed in the institutional setting, i.e. the legal regulations, rules governing work, and organizational hierarchies. A major difference between the X-ray Scanner and the two other technologies is that the users of the former has a degree of freedom because they need to interpret the picture as indicating something dangerous before responding with the prescribed action.

Dimensions of scripts	*Walk through Metal Detector (1)*	*X-ray machine (2)*	*Body scanner (3)*
Accessibility of technology to different kinds of users	Easy handling, **minimal** training required	**Training** for image interpretation necessary	Easy handling, **minimal** training required
	Usage limited to authorised personnel		
Specificity of purpose of technology	very high: avoid dangerous items and materials in secured area		
Kind and strength of influence utilised by script	Initiating re-interpretation: user decision based on signal/image provided by the machine		
Distribution of control of actions between user and artifact – flexibility of intended use	Strongly prescribed technological process		
	User has **little** control (only decision: when to start technology)	User has **significant** control	User has **little** control (only decision: when to start technology)
Homogeneity of distribution of control	**Stronlgy homogeneous** (no control after the technology is started)	**Heterogeneous** (operation of technology interspersed with user decisions)	**Strongly homogeneous** (no control after the technology is started)
Visibility/ Opacity of the script and its purpose for users	Transparent purpose, opaque concerning sensitivity	Transparent purpose, opaque because of random test images	Transparent purpose, opaque concerning the criteria of the automated image analysis
Material aspects of the situation, embeddedness in larger scripts			Passengers need to fulfil body norms to be processed correctly
	Embedded in a coercive setting of airport security that prescribes responses to signals	Embedded in a coercive setting of airport security that prescribes responses to interpretations of images	Embedded in a coercive setting of airport security that prescribes responses to signals

*Table 4: Comparison of the scripts of two technologies for airport security (important variations are set **bold**)*

Our analysis enables us to answer the question whether the increasing sophistication of technology increases or decreases the room of manoeuvre of human actors. The level of

sophistication – the amount and complexity of information processed and of information provided by the technology - is lowest for the metal detector, higher for the X-Ray scanner and highest for the body scanner. The levels of technological agency vary accordingly. However, 'degree of sophistication' or 'level of agency' are mono-dimensional descriptors of quite complex phenomena. Using our comparative framework, we could decompose these complex variables and show that although the three scripts are identical or very similar in many dimensions, they vary in the accessibility to users, distribution of control, and homogeneity of this distribution across the script. Owing to these differences, users' room of manoeuvre is lower for the metal detector than for the X-Ray scanner but higher for the X-Ray scanner than for the body scanner. This demonstrates that both hypotheses quoted in the beginning are too simple, and that there is no deterministic connection between 'levels' of technology and action opportunities of the user. With our multidimensional script analysis, we could show the reasons for this. Accessibility, Distribution of control and Homogeneity of Distribution of control vary independently of the level of sophistication. The level of influence neither increases nor decreases in a linear way.

4. Discussion: Where did we leave materiality?

An apparent discrepancy in our framework is that although we emphasised the importance of materiality in our reasoning for technologically mediated influence as a distinct form, we did not include a comparative dimension for it. We think that this discrepancy points to an important obstacle for comparative science and technology studies. Social studies of science and technology have no means for reducing the complexity of material properties. The natural and engineering sciences have developed theories at various levels of abstraction, which successfully reduce the complexity of material properties for their purposes. However, these reductions are not useful for social science investigations of materiality. Attempts to reduce the complexity of material properties in social studies of science and technology have led to highly general conceptualisations such as "The Mangle of Practice" (Pickering 1995) or ANT' use of sociological concepts (interests, speaker, enrolment, or power) that emphasise the role of materiality but abstract from its specific properties. The necessary move to a very high level of abstraction for reducing the complexity creates the dichotomy between conceptualisations and idiosyncratic descriptions of materiality we discussed in the introduction.

Faced with the problem of irreducible complexity, we choose a different approach. Instead of trying to include materiality directly in our comparative framework, we included the ways in which it influences human action, i.e. materialised scripts. Our main argument is that it is *the way in which*

influence is materially inscribed that produces a specific accessibility to users, specificity of purpose, distribution of control, kind and strength of influence used, homogeneity of distribution of control, visibility of the script and embeddedness in situations. By comparing scripts in these dimensions, we compare the influence that is exercised on humans through the materiality of technology, which is what matters to social studies of science and technology (see Gläser and Laudel 2015 for a corresponding suggestion for science studies).

At the same time, the study of materiality through scripts confers a specific openness to our comparative framework. Any comparative framework is open in the sense of its dimensions not being equally important in all comparisons. Depending on the aim of a comparative study, some dimensions may be relevant while others aren't. However, the specific role of materiality adds a particular flexibility to the framework. It is possible that particular forms of materiality exploited by scripts may also affect the composition of the comparative framework by requiring additional comparative dimensions. Furthermore, we cannot exclude the possibility that the inclusion of comparative dimensions directly referring to materiality might be required ad hoc for some comparisons.

5. Conclusions

The aim of this article is to further comparative studies of technologically mediated influence by theoretically positioning this kind of influence, deriving a comparative framework for technologically mediated influence and demonstrating that applying this framework can contribute new insights in the complexities of technologically mediated influence. Barring the application of the framework in a dedicated comparative empirical investigation, we could only deliver a 'proof of concept' by revisiting recurrent questions in technology studies and related fields. Nevertheless, we delivered this proof of concept by demonstrating the four possible functions of comparative frameworks for technologically mediated influence. First, we used a comparison of Fogg's seven 'persuasive technologies' and of three airport security technologies to demonstrate that the framework can connect case studies of technologies. Second, the detailed comparisons illustrated how the framework could be used to guide comparative studies by focusing empirical attention on particular properties of scripts and thus technologies. Since the comparisons informed the discussion of 'middle-range' theoretical claims, they also suggested how comparative studies could increase the theoretical yield of studies of technologies. Third, by revealing the complexity behind Fogg's concept of 'persuasive technologies', we demonstrated how techno-regulation studies could benefit from specific, theoretically guided comparisons. Finally, we positioned technologically

mediated influence in a social-theoretical framework. This enables specific comparisons between interactive, structurally mediated, and technologically mediated influence.

Among these affordances of our comparative framework, we find its potential contribution to the new studies of behavioural regulation through computer-based technologies particularly intriguing, and would like to elaborate them as an outlook on future work. A repeated argument in the discussion on techno-regulation is that technology is an easier means than law to enforce rules (Lessig 1999; Koops 2008; Hildebrandt 2009; Leenes 2011). This argument is akin to Latour's (1991b) more general argument about the primacy of technology in stabilising society. An illustrative example for that is the rule to fasten the seat belt, which is used by several techno-regulation scholars (Lessig 2006: 130; Hildebrandt 2009: 453-454; Yeung 2011: 3) and Latour (1992). Car drivers can or cannot follow the rule to fasten the seatbelt. If they don't they might be punished. In modern cars, technology can check the compliance with the rule and react with signs, annoying sounds, or blocking the engine unless the seatbelt is fastened.

In Algorithm studies, Ziewitz (2016b) found a common "structure of concerns", namely that of a drama in two distinct acts. "The first act introduces algorithms as powerful and consequential actors in a wide variety of domains." (ibid: 5). The second act discusses the difficulties involved in explaining how algorithms exercise influence (ibid: 6). Ziewitz then continues by identifying "three analytic themes that figure prominently in the algorithmic drama: agency, inscrutability, and normativity." (ibid: 7). Interestingly enough, algorithm studies appear to follow the same pattern of abstract discussion, idiosyncratic case study, and use of 'sample technologies' (see the contributions in Ziewitz 2016a).

Both lines of thinking can benefit from systematic comparisons of technologies, be it to other technologies or to other forms of exercising influence. Techno-regulation would benefit from moving beyond the merely illustrative use of examples and executing detailed comparisons of techno- and rule-regulation, thereby extending our knowledge about the ways in which human behaviour is regulated in particular circumstances through specific mechanisms of influence with specific effects. If this isn't done, the rather fundamental statements concerning social order and freedom cannot be empirically substantiated beyond anecdotal evidence. Algorithm studies could use comparisons to address the questions of agency, inscrutability and normativity by applying a comparative framework to the study of algorithms. We believe to have demonstrated that at least some of the inscrutability can be done away with by such a framework.

Social studies of technology address one of the central concerns of modern societies and social science, namely the influence on human behaviour that is exercised through technology. In society, democratic representatives, the law, political and economic interest groups and the general public

increasingly notice and debate the ways in which technology is used to influence behaviour. In philosophy, political theory, law, sociology, computer science and many other fields the emerging opportunities of technologically mediated influence and the new conceptual problems arising from them are discussed. This creates an increasing demand for contributions from science and technology studies.

We believe that these new societal and scientific concerns need to be addressed not only conceptually but also by empirical research, and that one contribution science and technology studies can make is methodological. The question how technologically mediated influence can be studied gains urgency. For an effective contribution by science and technology studies, we must go beyond the 'odd couple' of empirical description and fundamental statements. This is why we proposed a comparative framework that supports 'middle-range' generalisations by enabling comparisons of technologies as well as comparisons of technologically mediated influence to other forms of influence. Both kinds of comparison will help to position technology more firmly in social theory.

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